Devils Creek Culvert Concrete Strength Evaluation, Kodiak, Shannon & Wilson, September 20, 2012

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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September 20, 2012

HDR Alaska, Inc.
2525 C Street, Suite 305
Anchorage, Alaska 99503

Attn: Mr. Carl Siebe, P.E.

RE: DEVIL'S CREEK CULVERT CONCRETE STRENGTH EVALUATION, KODIAK, ALASKA

This letter report presents the results of our visual assessment, site reconnaissance, concrete testing, and concrete strength evaluation for the existing box culvert at the above referenced project at the Kodiak Airport in Kodiak, Alaska. The purpose of our site visit and concrete testing is to provide data to be used in an evaluation of the integrity of the existing culvert that conveys Devil's Creek across the Kodiak Airport property. To accomplish this, the existing concrete culvert was tested in numerous locations throughout the length of each of the two bays with a Schmidt Hammer and four concrete core samples were taken from the top of the culvert to be tested for compressive strength. Presented in this report are descriptions of the site and project, our visual assessment observations, field and laboratory test procedures, an evaluation of the existing culvert, and our recommendations for future improvements to the culvert.

Authorization to proceed with this work was received in the form of a signed contract from Mr. Mark Dalton of HDR Alaska, Inc. (HDR) on July 27, 2012. This work was performed according to our proposal dated May 15, 2012.

SITE AND PROJECT DESCRIPTION

The Devil's Creek culvert is located on Kodiak Airport property at 1647 Airport Way near Kodiak, Alaska. A vicinity map of the Kodiak area is included as Figure 1. We understand that the original Devil's Creek culvert was approximately 515 feet long (constructed at an unknown date) and that an approximately 275 feet long extension was constructed on the south end of the culvert in 1951. A site map is included as Figure 2 that provides a view of the airport area including prominent site features and the approximate culvert location. The 790-foot culvert has cross sectional dimensions of approximately 23 feet wide by 8.5 feet high. As-built drawings indicate that the concrete floor and ceiling of the box culvert are approximately 1.25 feet thick, and that the walls are approximately 1.1 feet thick. There is an 8-inch thick center dividing wall running down the length of the culvert forming two "bays" (referred to in this report as East Bay and West Bay) with open dimensions of roughly 10 feet wide by 6 feet tall.

Based on the July 2, 2010 report *Hydrology and Hydraulics Review, Devils Creek Culvert, Kodiak* Airport presenting the observations made by Alaska Department of Transportation & Public Facilities (ADOT&PF) personnel, it is apparent that the culvert is showing signs of distress such as minor spalling, erosion of concrete at the invert, exposure of rebar reinforcement in the floor, cracking in the ceiling, water seepage, and efflorescence. We understand that the ADOT&PF is considering several options for repairing or replacing the culvert and that our evaluation of the condition and strength of the concrete in the existing structure will be considered in choosing the next course of action.

SITE VISIT

From August 22 to August 24, 2012 an experienced engineer from our office visited the site along with Ray Gamradt, from HDR, for a visual assessment of the existing culvert, to perform tests non-destructive concrete tests with a Schmidt Hammer, and to recover concrete core samples of the existing concrete. Both representatives walked the length of both bays to photograph and note areas where signs of distress were observed within the culvert. During the visual assessment, our representative also took readings with Schmidt Hammer at approximate 50-foot intervals to assess potential variations in the strength of the existing concrete throughout the length of both of the bays. A total of seven concrete core samples were then recovered (four by Shannon & Wilson and three by HDR) for laboratory testing. The four concrete core samples recovered by our representative were returned to our Anchorage laboratory for compressive strength testing.

Visual Assessment Observations

At the time of our visit, the Devil's Creek channel was generally concentrated through the west bay of the culvert (Culvert 1). The depth of water flowing within Culvert 1 was generally less than one foot. There was little to no flow through the east bay of the culvert (Culvert 2). Our visual assessment generally appeared to agree with the ADOT&PF observations described in their July 2, 2010 report. We observed signs of distress within the culvert that included the erosion of concrete near the invert, exposure of numerous pieces of rebar reinforcement at the invert, minor spalling, hairline cracking in the culvert walls, map cracking and efflorescence in the ceiling, and water seepage through occasional cracks in the ceiling.

In general, the most noticeable erosion of concrete was observed on the floor and in roughly the bottom two feet of the walls of the culvert. Concrete erosion was observed throughout both bays and appeared to be up to roughly ½ -inch into the walls, and was observed to be significant (estimated at more than 2 inches in some locations) in the culvert floor. Concrete erosion into the walls generally resulted in the exposure of aggregate. Photo 1 on Figure 6 shows a location with some of the more significant aggregate exposure due to concrete erosion. However, as shown in Photos 2 and 3 on Figures 6 and 7, erosion into the walls around the culvert bend (approximate Stations 0 through 275) of both bays was observed to be more extensive and resulted in the spalling of concrete and the occasional exposure of rebar near the bottom of the walls in some locations. The erosion of concrete in the floor of the culvert resulted in the exposure and undercutting of numerous pieces of lateral and longitudinal rebar throughout a significant portion of both bays of the culvert. Photos 4 through 6 on Figures 7 and 8 show exposed lateral and longitudinal rebar at the invert of Culverts 1 and 2.

Concrete erosion was also observed on the side walls in occasional areas of the culvert beneath what appear to be form holes (from when the culvert was constructed) and near the inlet and outlet of Devil's Creek through the culvert. Photos 7 and 8 on Figure 9 show a portion of Culvert 1 and Culvert 2, respectively, where water appears to periodically seep through the form holes and erode the concrete down the wall of the culvert. We believe that the erosion of concrete at the inlet and outlet of the culvert; shown in Photos 9 and 10 on Figure 10, respectively; is due a the combination of weathering (exposure to rain, snow, wind, etc.) and the flow of Devil's Creek during the various water levels throughout the year. This can be seen in the decrease in the amount of erosion on the walls as the height above the invert increases.

In addition to the erosion of concrete in the walls of the culvert, cracks were also observed throughout the majority of the walls in both bays of the culvert. These cracks generally consisted of hairline cracks as shown on Photos 11 and 12 on Figure 11, but larger cracks (commonly up to roughly ¼ to ½ -inch wide) were also observed to be scattered throughout both bays of the culvert as shown on Photos 13 and 14 on Figure 12. The larger cracks commonly resulted in a white, gray, or brown efflorescence on the wall; relatively minor spalling of the concrete; or water seepage through the crack. Spalling of the concrete was generally observed to be directly adjacent to the larger cracks, and usually occurred where water seepage was observed. Seeping water through the cracks was generally observed to be minor, and steady streams/drips of water were not observed to be running down the walls of the culvert during our site visit.

Organic material was also observed to be on the walls near the inlet and outlet of the culvert. A green moss/algae material was observed to be growing on the inner wall of Culvert 1.

As shown on Photo 15 on Figure 13, this was generally observed to be confined to the last 20 to 30 feet before the outlet. Organic material near the inlet was observed to be caught on an abandoned utility wire hanging on the outer wall of Culvert 2 as shown on Photo 16 on Figure 13. This was observed near the top of the culvert, and seems to confirm the claim that there are times when the volume of water flowing through Devil's Creek puts the existing culvert at or over capacity.

The ceiling of the culvert was also observed to contain cracks of various sizes. Map cracking in the ceiling was generally observed to consist of hairline cracks between roughly Stations 40 and 240 of both bays of the culvert. This generally coincides with the bend in the upstream 1/3 of the culvert. Where map cracking was observed, the ceiling commonly had minor efflorescence, and also had areas of "snowflake-like" particles hanging from the concrete. Photos 17 and 18 on Figure 14 show areas where map cracking was observed in Culvert 1 and Culvert 2, respectively.

Significant cracks (with separation greater than roughly ¼ inch wide) were observed to be relatively common in the ceiling of the culvert. Photos 19 through 24 on Figures 15 through 17 show examples of some of the more significant cracks observed in the ceiling of the culvert. These cracks generally were observed to have spalling of the concrete on either side of the crack, efflorescence, and water seepage. Photos 23 and 24 on Figure 17 show two of the locations where significant water seepage (dripping water through the crack) was observed during our site visit. The concrete on the ceiling appeared to be wet for up to approximately 20 feet downstream of the crack, and efflorescence was also observed in these areas.

Many of these significant cracks in the ceiling were also observed to contain stalactites forming below them. Photos 25 and 26 on Figure 18 show examples of stalactites forming from the ceiling that were observed to be up to about 6 inches long. The stalactites were relatively common in the ceiling throughout both bays of the culvert. The longer stalactites were generally observed in the areas where significant water seepage was observed during our site visit.

<u>Schmidt Hammer Testing</u>

During our site visit, several locations throughout both bays of the culvert were tested with a Schmidt Hammer. The Schmidt Hammer test is a non-destructive method of evaluating the in-place strength of concrete. Our tests were performed in general accordance with the procedures outlined in ASTM C 805 with the exception that the number of hammer tests at a given point were fewer than the recommended ten in the testing method. These tests were conducted on the ceiling and both side-walls at 50-foot intervals (measured with a rag tape) to provide even coverage over the length of the culvert. Tests were also conducted on most of the core samples recovered by Shannon & Wilson and HDR during our site visit.

Tables summarizing the data obtained from the Schmidt Hammer tests as well as approximate locations of the testing locations are provided on Figures 4 and 5 for the West and East Bays, respectively. Test locations indicated on the tables in these figures (i.e. left, right, and top) were located on the inside of the culvert, looking down-stream (or up-station). Testing on the left and right walls of each bay was generally done in areas above the bottom 2 feet where concrete was not eroded. Additionally, approximate six to eight tests were conducted for each data point on the table and averaged in the field for reporting purposes. Schmidt Hammer test results presented on Figures 4 and 5 include an adjusted Schmidt Hammer reading that accounts for the angle of the hammer at the time of the test. The test readings are increased when the hammer is pointed down to test an area of concrete on the ground, and decreased when the hammer is pointed up to test concrete on the ceiling. The Schmidt Hammer results provide relative strength data and were correlated to compressive strength testing of our core samples to estimate the compressive strength of the concrete inside of the culvert.

Core Sampling

During our site visit, EMC Engineering, LLC (EMC) was subcontracted by HDR to drill core samples of the concrete in the top of existing culvert. An EMC representative drilled a total of seven core samples (four recovered by Shannon & Wilson and three recovered by HDR). The four concrete core samples recovered by our engineer (Core Samples SW-1 through SW-4) were taken at the locations shown on the site plan presented as Figure 2. These samples were returned to our Anchorage laboratory for compressive strength testing and additional Schmidt Hammer tests were taken. The cores were taken from along the length of the culvert, outside of the airport runway and taxiways, to provide coverage in the original construction and extension to the culvert for comparison. The samples were drilled by EMC using an electric coring machine equipped with a 4-inch outer diameter (OD), diamond core bit. We understand that the coring holes were repaired by placing a steel plate over the hole and burying with excavated soils after we demobilized from the field.

LABORATORY TESTING

Compression tests were performed on our four concrete core samples recovered. The cores were prepared and the tests performed in general accordance to the procedures outlined in

ASTM C 42. The concrete core samples were approximately 15 inches long and contained a rebar mat near the top and bottom of the core. The exception to this was Core Sample SW-2 which was broken into four separate pieces when it was recovered. Our core samples were generally cut so that we used the middle section (between the rebar mats). Two of the core samples tested for compressive strength were shorter than twice the core diameter, so a correction factor was applied in conformance with the ASTM guidelines.

Schmidt Hammer tests were taken on both ends of the four cores to compare to the results of the tests performed in the field. Schmidt Hammer and compressive test results of the core samples are summarized on Figure 3. The results shown on Figure 3 were used to estimate the compressive strength of the concrete at the locations tested with the Schmidt Hammer in the field. Figures 4 and 5 show the estimated compressive of the concrete tested in the field based on the Schmidt Hammer and compressive strength results found during laboratory testing.

CONCRETE EVALUATION

As shown on Figures 4 and 5, Schmidt Hammer test results varied along the length of the bays of the culvert between an adjusted average reading of 30 and 41, but one of the core samples tested (Core Sample SW-2) had an adjusted average reading of 17. Based on the Schmidt hammer readings taken on the concrete core samples tested for compressive strength, there appears to be a relatively strong correlation between the hammer results and compression test results.

Typically, concrete is designed to have compression strengths of at least 3,000 to 4,000 pounds per square inch (psi). According to our compression testing, all but one of the samples tested (Core Sample SW-2) yielded compressive strengths greater than 5,000 psi (ranging from 2,360 to 7,370 psi). The estimated concrete strength of the existing culvert, based on the correlation between our Schmidt Hammer reading and compressive strength testing of the core samples, generally appeared to yield compressive strengths of greater than 5,000 psi.

Though the concrete generally meets typical strength criteria several other conclusions about the concrete integrity can be made in observing the appearance of the concrete cores and how they failed in the compression test. One of the samples collected for testing (Core Sample SW-2) was recovered broken into four pieces and was observed to contain gaps in the concrete around the aggregate. This sample failed in more of a crumbling mode without a clean break characteristic of a high-quality concrete. Based on our observations of the core sample and the way that it crumbled during failure we believe that the area around the location of Core Sample

SW-2 might not have been properly vibrated during the construction of the culvert. Therefore, it is possible that other areas of the culvert may also have similar strength deficiencies that were not observed during our field and laboratory tests.

CONCRETE CULVERT RECOMMENDATIONS

Considering the results of our compression testing alone, we believe the existing concrete culvert is likely strong enough to continue using provided that some repair work is performed. However, we believe that some of our observations of the concrete culvert (i.e., the condition and strength of Core Sample SW-2, significant cracks in the ceiling, water seepage, and the presence of stalactites) may show evidence of other areas of the culvert that have strength deficiencies that make the culvert less than desirable for continued use. As such, there appears to be a significant amount of repair work that may need to be performed in order to repair the potentially weakened areas of the culvert. Repair work may include maintenance to replace concrete that has eroded away from near the bottom of the culvert as well as near the inlet and outlet. We believe that the formation of stalactites may be the result of chemicals within the concrete being washed down through the crack as the condition of the concrete deteriorates. Therefore, many of the significant cracks in the ceiling that have resulted in water seepage and the formation of stalactites may also need to be repaired.

Based on the relatively thin layer of soil observed over the culvert, outside of the paved runway and taxiway areas, we believe that a vapor barrier should be considered over the top portions of the culvert that are not located below asphalt. A vapor barrier or impermeable geosynthetic (such as a geosynthetic clay liner) would reduce the risk of water seepage through the cracks in the ceiling of the culvert, thereby decreasing the rate at which the concrete is deteriorating near the existing cracks.

CLOSURE AND LIMITATIONS

This letter presents our visual assessment observations, the results of field and laboratory testing, and our evaluation of the existing concrete condition of the Devil's Creek culvert based on our observations and test results. The information included in this report should be considered to only represent the characteristics of the concrete culvert at the locations sampled and tested. Variations can occur in a concrete culvert resulting in variable characteristics. We have prepared the attachment *Important Information About Your Geotechnical/Environmental Report* to assist you in understanding the limitations of this letter.

Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, or you question the authenticity of the report please contact the undersigned.

We appreciate this opportunity to be of service. Please contact the undersigned at (907) 561-2120 with questions or comments concerning the contents of this report. We look forward to the opportunity to work with you in the future.

SHANNON & WILSON, INC.

Prepared By:

STATE OF ALASKA
49TH
Kyle Brennan
CE-11122
9-20-12
REGISTERED PROFESSIONAL ENGINEER

Kyle Brennan, P.E.
Senior Associate

Attachments: Figure 1: Vicinity Map
Figure 2: Site Plan
Figure 3: Concrete Core Sample Strength Test Results
Figure 4: West Bay Schmidt Hammer Results
Figure 5: East Bay Schmidt Hammer Results
Figures 6 through 18: Photo Pages
Important Information About Your Geotechnical/Environmental Report

RCH:KLB/sjg

Approximate Project Location

NOT TO SCALE

Devil's Creek Culvert
Concrete Strength Evaluation
Kodiak, Alaska

VICINITY MAP

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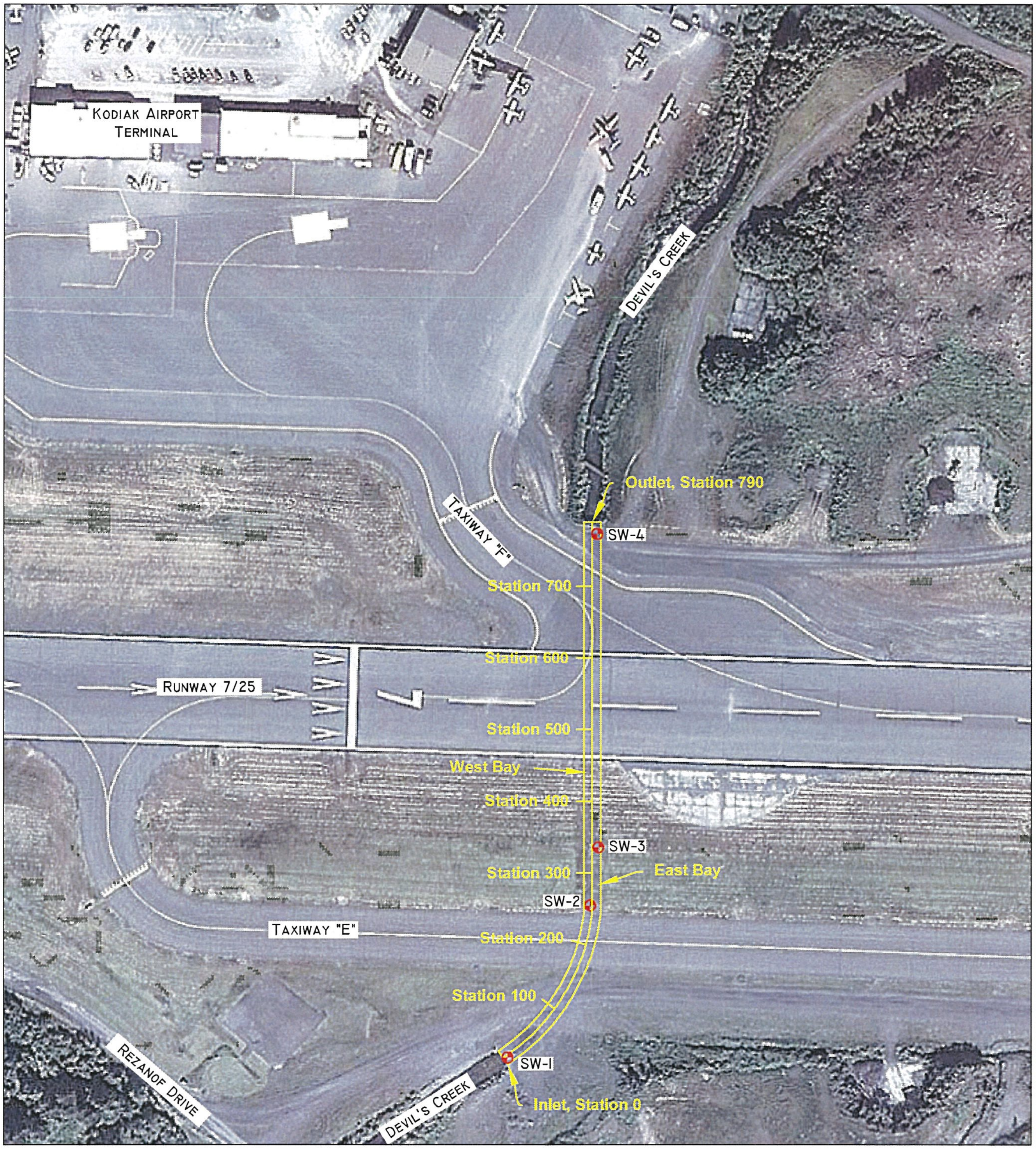
FIG. 1



Map adapted frfom aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth TM Mapping Service.

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APPROXIMATE SCALE IN FEET

N

LEGEND

SW-1 Approximate Location of Concrete Core Sample SW-1, Recovered by Shannon & Wilson, August 2012

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SITE PLAN

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FIG. 2

Concrete Core Sample Laboratory Test Results

Core Name	Test Location (All Cores Taken From Ceiling)	Adjusted Schmidt Hammer Reading*		Average Reading	Laboratory Compressive Strength	Average Diameter	Average Length	Length to Diameter Ratio	L/D Correction Factor	Corrected Compressive Strength
	Culvert number, Station, distance from east/west bay wall	Lab on Cut Core Top	Lab on Cut Core Bottom	Adjusted	(psi**)	(inch)	(inch)	(L/D)	From ASTM C 42	(psi**)
SW-1	East Bay, Station 11, 9.6 feet from east wall	39.5	34	37	7370	3.682	7.897	2.14	1.00	7370
SW-2	West Bay, Station 252, 2 feet from east wall	18	16	17	2570	3.698	4.468	1.21	0.92	2360
SW-3	East Bay, Station 336, 2.5 feet from east wall	30	32	31	5310	3.704	6.493	1.75	0.98	5200
SW-4	East Bay, Station 778, 3 feet from east wall	32	36	34	6080	3.698	7.850	2.12	1.00	6080

* The Schmidt Hammer readings are adjusted, based on a graph provided by the manufacturer, for the angle of the hammer at the time of the test (i.e., increased when the hammer is pointed down and decreased when it is pointed up).

** pounds per square inch (psi)

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CONCRETE CORE SAMPLES STRENGTH TEST RESULTS

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FIG. 3

West Bay Laboratory and Field Test Results								
Test Location	Schmidt Hammer Reading			Adjusted Schmidt Hammer Reading*			Average Reading	Estimated Concrete Strength***
(Station)	Left	Top	Right	Left	Top	Right	(adjusted)	(psi**)
1	39	40	38.5	39	36	38.5	38	7700
50	30	37.5	39	30	33.5	39	34	6080
100	30.5	36.5	26.5	30.5	32.5	26.5	30	4800
150	36	38	39.5	36	34	39.5	37	7370
200	32	38.5	34	32	34.5	34	34	6080
250	40	39.5	41	40	35.5	41	39	8100
300	34	42	44.5	34	38.5	44.5	39	8100
350	33	42	32	33	38.5	32	35	6500
400	38	41	35	38	37.5	35	37	7370
450	36	39	34	36	35	34	35	6500
500	41	45	39.5	41	41.5	39.5	41	8900
550	32	47	38	32	44	38	38	7700
600	42	41	34	42	37.5	34	38	7700
650	34	45	35	34	41.5	35	37	7370
700	33	47	37	33	44	37	38	7700
750	38	38	32	38	34	32	35	6500
789	42	45.5	34.5	42	42	34.5	40	8500

* The Schmidt Hammer readings are adjusted, based on a graph provided by the manufacturer, for the angle of the hammer at the time of the test (i.e., increased when the hammer is pointed down and decreased when it is pointed up).

** pounds per square inch (psi)

*** Estimated concrete strength is based from the results of the adjusted Schmidt Hammer readings and compressive strengths of the concrete core samples collected from the ceiling of the culvert on 8/24/2012 and reported on Figure 3.

Note: Hammer reading locations indicate general location on interior of bay wall at each station. Readings consist of a field average of approximately 6 to 8 individual readings in a 4 to 5 square foot area. Readings on walls were generally conducted o

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WEST BAY
SCHMIDT HAMMER RESULTS

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FIG. 4

East Bay Laboratory and Field Test Results								
Test Location	Schmidt Hammer Reading			Adjusted Schmidt Hammer Reading*			Average Reading	Estimated Concrete Strength***
(Station)	Left	Top	Right	Left	Top	Right	(adjusted)	(psi**)
1	34	36	38	34	32	38	35	6500
40	38	38	35.5	38	34	35.5	36	6900
90	34	44	36	34	40.5	36	37	7370
140	35	42	35	35	38.5	35	36	6900
190	32	34	36	32	30	36	33	5800
240	31	38	31	31	34	31	32	5500
290	35	41	31	35	37.5	31	35	6500
340	34.5	38.5	42	34.5	34.5	42	37	7370
390	34	39	36	34	35	36	35	6500
440	33	40	36	33	36	36	35	6500
490	42	41	40	42	37.5	40	40	8500
540	34	42	39	34	38.5	39	37	7370
590	36	40	35.5	36	36	35.5	36	6900
640	34.5	43.5	34.5	34.5	40	34.5	36	6900
690	36	37	40	36	33	40	36	6900
740	34	41	39.5	34	37.5	39.5	37	7370
787	33	46	41.5	33	42.5	41.5	39	8100

* The Schmidt Hammer readings are adjusted, based on a graph provided by the manufacturer, for the angle of the hammer at the time of the test (i.e., increased when the hammer is pointed down and decreased when it is pointed up).

** pounds per square inch (psi)

*** Estimated concrete strength is based from the results of the adjusted Schmidt Hammer readings and compressive strengths of the concrete core samples collected from the ceiling of the culvert on 8/24/2012 and reported on Figure 3.

Note: Hammer reading locations indicate general location on interior of bay wall at each station. Readings consist of a field average of approximately 6 to 8 individual readings in a 4 to 5 square foot area. Readings on walls were generally conducted o

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EAST BAY
SCHMIDT HAMMER RESULTS

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FIG. 5

PHOTO 1: CENTER WALL AT CULVERT INLET.

PHOTO 2: TOP OF CENTER WALL AT CULVERT INLET.

DEVIL'S CREEK CULVERT
CONCRETE STRENGTH EVALUATION
KODIAK, ALASKA

PHOTO PAGES

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FIG. 6

PHOTO 3: LOWER EAST WALL OF WEST BAY AT STATION 90.

PHOTO 4: WEST WALL OF WEST BAY AT STATION 1955.

DEVIL'S CREEK CULVERT
CONCRETE STRENGTH EVALUATION
KODIAK, ALASKA

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FIG. 7

PHOTO 5: LOOKING EAST AT CEILING OF WEST BAY AT STATION 240.

PHOTO 6: TOP CORNER OF WEST WALL OF WEST BAY AT STATION 260.

DEVIL'S CREEK CULVERT
CONCRETE STRENGTH EVALUATION
KODIAK, ALASKA

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FIG. 8

Photo 7: West wall of West Bay at Station 420.

Photo 8: Looking west at ceiling of West Bay at Station 465.

Devil's Creek Culvert
Concrete Strength Evaluation
Kodiak, Alaska

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Fig. 9

PHOTO 9: LOOKING EAST AT CEILING OF WEST BAY AT STATION 495.

PHOTO 10: CENTER OF CEILING OF WEST BAY AT STATION 620.

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CONCRETE STRENGTH EVALUATION
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FIG. 10

Photo 11: Floor of West Bay at Station 685.

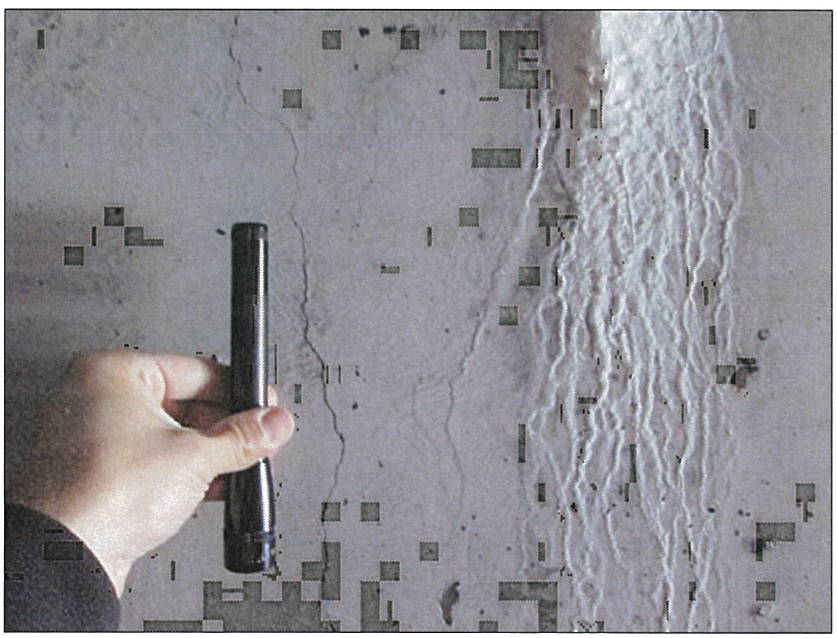

Photo 12: West wall of West Bay at Station 745.

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Fig. 11

PHOTO 13: WEST WALL OF WEST BAY AT STATION 770.

PHOTO 14: CEILING AND TOP CORNER OF WEST WALL OF EAST BAY AT STATION 55.

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FIG. 12

PHOTO 15: EAST WALL OF EAST BAY AT STATION 90.

PHOTO 16: LOWER EAST WALL OF EAST BAY AT STATION 115.

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FIG. 13

PHOTO 17: CENTER OF CEILING OF EAST BAY AT STATION 145.

PHOTO 18: LOOKING WEST AT CEILING OF EAST BAY AT STATION 150.

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CONCRETE STRENGTH EVALUATION
KODIAK, ALASKA

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FIG. 14

PHOTO 19: EAST WALL OF EAST BAY AT STATION 240.

PHOTO 20: LOOKING WEST AT CEILING OF EAST BAY AT STATION 245.

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CONCRETE STRENGTH EVALUATION
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FIG. 15

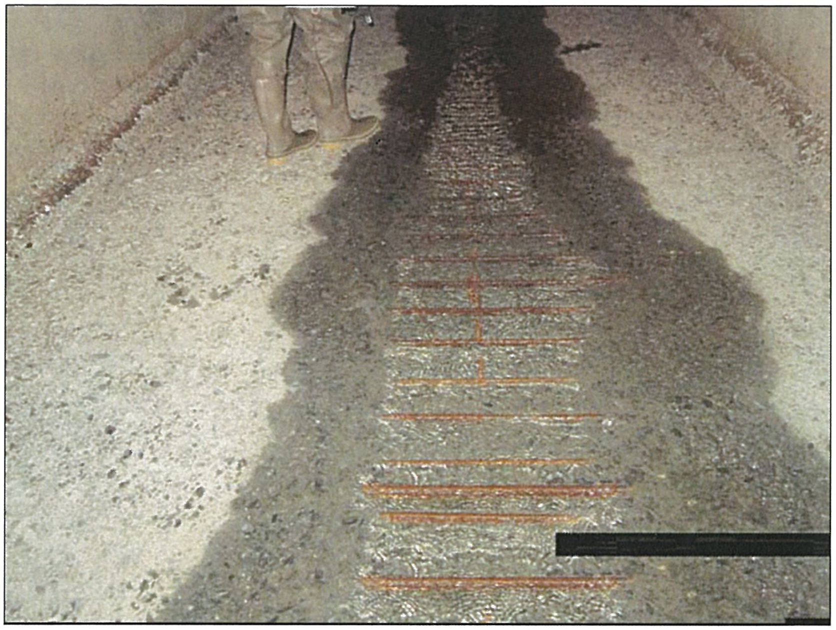

PHOTO 21: FLOOR OF EAST BAY AT STATION 300.

PHOTO 22: LOWER EAST WALL OF EAST BAY AT STATION 420.

DEVIL'S CREEK CULVERT
CONCRETE STRENGTH EVALUATION
KODIAK, ALASKA

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FIG. 16

PHOTO 23: FLOOR OF EAST BAY AT STATION 605.

PHOTO 24: LOOKING EAST AT CEILING OF CULVERT 2 AT STATION 610.

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CONCRETE STRENGTH EVALUATION
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FIG. 17

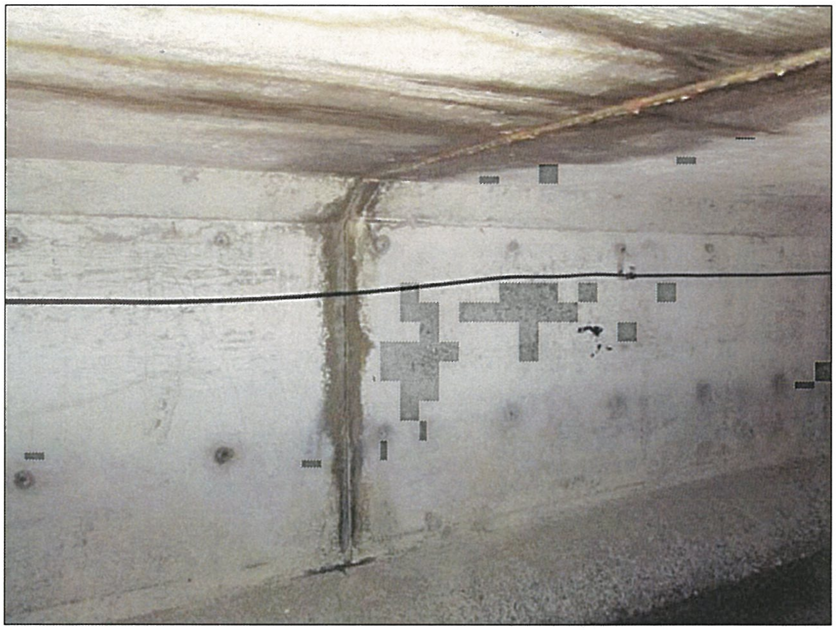

PHOTO 25: EAST WALL OF EAST BAY AT STATION 650.

PHOTO 26: CENTER OF CEILING OF EAST BAY AT STATION 745.

DEVIL'S CREEK CULVERT
CONCRETE STRENGTH EVALUATION
KODIAK, ALASKA

PHOTO PAGES

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FIG. 18